CHEMISTRY

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Make Way For Electrons

➤ A VERY SMALL amount of the right sort of impurity is the secret of germanium's success as a semi-conductor of electricity. Knowing this has enabled scientists to convert germanium's relative, silicon, into a semi-conductor also, and to extend the list of possible additions to these elements which will increase their semi-conducting power or adapt it to special circumstances. The number of electron donors and acceptors is growing.

An electron donor in this case is an atom of an element in the next group of the Periodic Table, which can, because of its electronic structure, pass along an electron but prevent its return. An acceptor can take one of germaninum's electrons but cannot send one back. Only a few such misfit atoms are necessary to affect the electrical properties of a comparatively large mass of the semi-conducting element.

This is another example of the startling effects of a tiny quantity of matter when its electronic qualities are put to use. Taken atom by atom, means can be devised to produce important effects from seemingly small phenomena. A radio beacon has been invented whose oscillations are kept in motion by the radioactive disintegrations of a fission product. Tiny pulses of light can be amplified cascade-fashion to extend the limits of the universe as seen by our biggest telescopes. Very high temperatures are signaled through the spectroscope from shock waves too brief to heat the tube through which they flash, yet they may set off the fusion reaction like that which heats the stars.

For those who want to lead the way toward tomorrow's power, the path would seem to be in the direction of atomic forces now and, perhaps, on into the still more mysterious subnuclear field.

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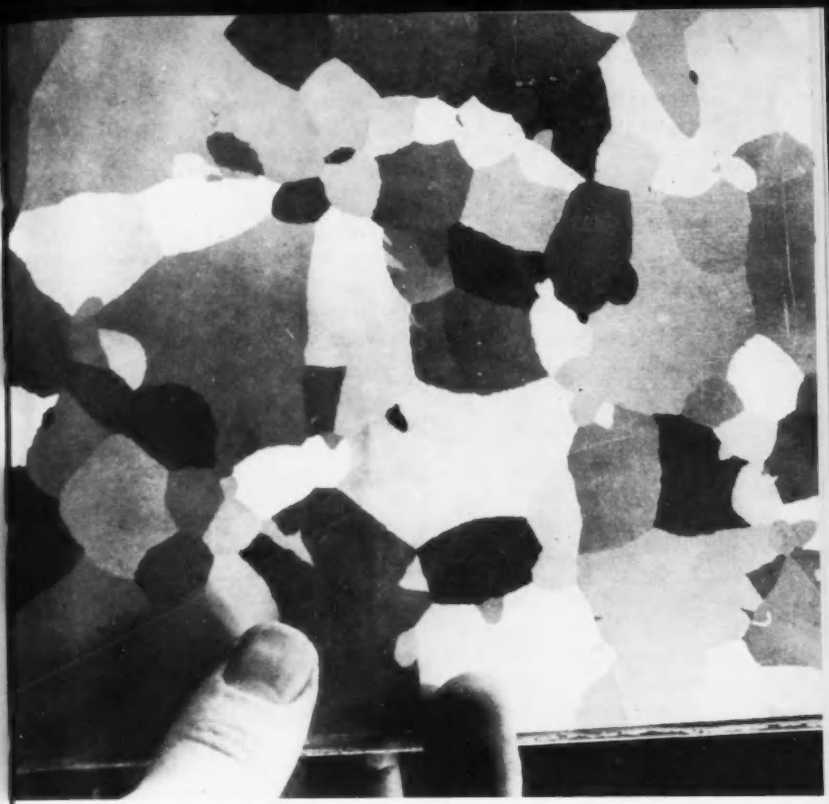


▸ GERMANIUM *etched to bring out crystal faces shows the boundaries between different kinds of crystals. The boundary between the crystals of two unlike elements is known as an "n" junction when germanium receives electrons, or as a "p" junction when conduction is by the so-called "hole motion". This photograph comes from Dr. Karl Lark-Horovitz, Purdue University, Lafayette, Ind., in whose laboratory much of the fundamental work on germanium as a semiconductor is being done.*

Electrons in Germanium

▸ JUST AS each chemical element has its unique properties, each seems to find some special use based on these unique peculiarities. Just as iron allowed man to discover magnetism and silver permitted him to invent photography, the element germanium is now in-

troducing him to a new series of electrical phenomena.

Germanium is in between the classes of substances known as insulators and those called conductors of electricity. It is a semiconductor.

Some of the electrical consequences of germanium being a semiconductor have been discovered by trying out one thing and then another. Theory has been added to bring unrelated observations together. A very picturesque vocabulary has grown up, in which holes climb over barriers or slide down hills, electrons jump into approaching holes, and according to one group of workers, both are neutralized by "deathnium."

The student who encounters these statements for the first time may think he has stumbled into a very strange wonderland, indeed.

The electron plays an important part in the laws of this new chemical country.

Chemists, of course, find the electron an old friend. Bound into an inner orbit of any atom, it contributes to the structure which makes that atom different from an atom of some other element.

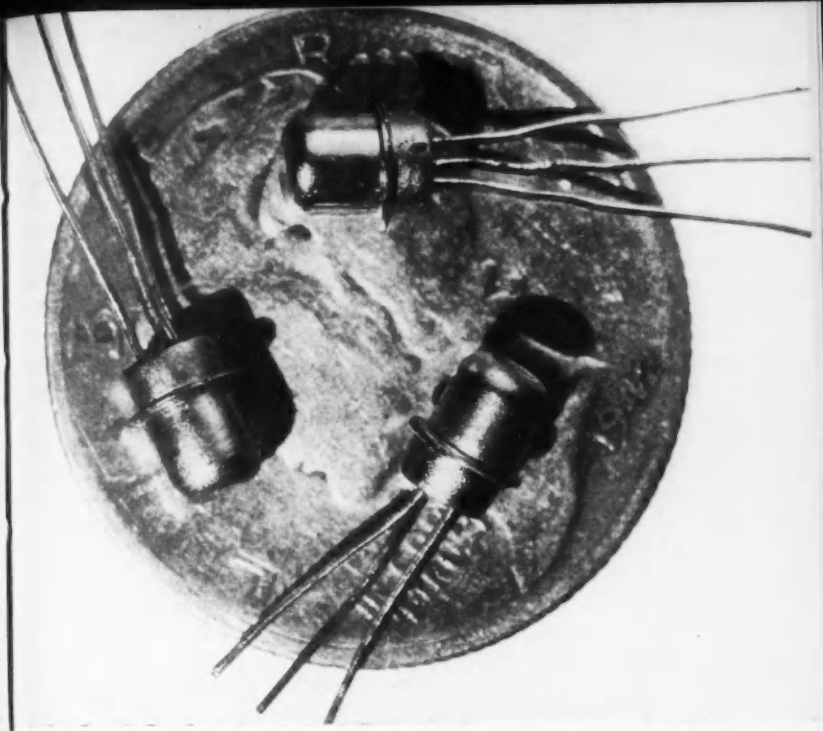
Skimming around an outer orbit of an atom, an electron may contribute to the force the chemist knows as valence. This name defines the power which makes elements unite to form compounds.

The electron is the unit of electricity, and is described as having a negative charge. Scientists suspect that this nomenclature is unfortunate, but it has been used too long now to do anything about it. We must just accept the idea that we what we know as an electric current is a stream of negatively charged traveling electrons.

Electrons run along the surface of a copper wire. They dodge between the atoms of many crystals. They are all alike, so that an electron may break away from the outer orbit of one atom and slip into the vacancy left in a different atom by another electron on the loose.

Benjamin Franklin, whose playful experiments with static electricity were important steps in discovering the nature of this new form of energy, did much to convince the world that electricity is of two kinds, negative and positive. Scientists still do not understand all the implications of this description. For a long time it was thought that the electron represented the only kind of charge, called negative, and that Franklin's positive electricity was just the lack of electrons. Now some facts do not bear out this simple explanation completely, but as an introduction to semiconductors it does very well.

In the vocabulary of the semiconductors, an electron, when it moves out of its orbit, leaves a "hole." This hole has many of the



▸ THREE *sub-miniature transistors of the p-n-p type, made of a layer of germanium between two layers of indium, are shown resting comfortably on a dime. This transistor, labelled M-1, has just been announced by Philco's Electronic Tube and Transistor Division as the smallest such device yet developed.*

properties expected of a positively charged particle, like the electron but of opposite sign.

There is a belief among theoretical atomic physicists that two such particles of opposite sign, when they come too closely together, will annihilate each other. The researcher into the ways of semiconductors expresses the idea somewhat differently. He says the electron falls into the hole. The hole "disappears" because the electron has filled it. The electron is no longer detected as a free-moving charge because its individuality has been merged into the entity of the atom which it has joined. The strict mathematician says both pictures are wrong, but that the true state of affairs in the atom cannot be pictured and can really be described only by a mathematical formula. But the

physicist retaliates by stating that such a combination causes radiation, which he has photographed.

For pictorially minded people, the idea of migrating holes is sometimes compared to a partly filled auditorium where there are more chairs than people. In such an auditorium the first members of the audience might fill the back rows of chairs, but, finding that they could not hear well there, one individual after another might move farther forward, often moving to a chair just vacated by someone else. Finally most of the front chairs might be filled and most of the back ones empty. To the speaker on the stage it might look as though the empty chairs had moved back at the same time that the people had moved forward.

Such comparisons are never satisfactory to the physicists struggling to explain unfamiliar phenomena, but they may indicate something about why the words in use to describe some of the phenomena were chosen.

The "barriers" and "hills" of the semiconductor vocabulary refer to energy levels, and come directly from the curves drawn from energy measurements.

The forces involved in the phenomena measured come from the innate tendency of electrons to migrate from one atom to another. These forces are responsible for electro-chemical effects, including currents drawn from batteries.

The way they operate is related to the atomic structure of the chemical elements. The periodic change in properties from one element to the next is linked to addition of protons and neutrons to the nucleus of the atom, as scientists have lately come to understand. These additions to the nucleus allow more electrons to join the outer orbit of the atomic system. The valences of the atoms are governed by the number of electrons in these orbits.

As one layer after another of electron orbits is added, the space around the atomic nucleus tends to be filled with electron paths grouped in stable configurations. These are known as "shells." A complete shell is marked by the chemical inertness of the gases helium, neon, argon, krypton and xenon. Each of these elements has eight electrons tightly held in its outer shell.

The next heavier element which follows each of these inert gases is an alkali metal with a valence of one. Chemically these metals are very active. Electronically this is interpreted as one electron starting a new outer shell.

Detectable electrical energy is found where two different elements touch, or where there is a difference in valence, so that electrons migrate from one substance to another. Alessandro Volta,

nearly a century and a half ago, was surprised to discover this effect when he piled discs of dissimilar metals, like coins, together. He got an electric shock when he put, between each pair of metal discs, pieces of blotting paper wet with enough salt water to set the reaction going.

The characteristic property of semiconducting substances is that their electrons will move smoothly from a material which has an excess of electrons, to a nearby material with a less number, but will not move in the opposite direction.

Explained in terms of valence, this means that Group IV elements in the Periodic Table, especially silicon and germanium, whose valences are 4, receive electrons from Group V elements, especially phosphorus and arsenic. On the other hand Group IV elements pass on electrons to elements in Group III, such as boron, aluminum, indium and gallium. Stated in other terms, Group V elements are *donors* (of electrons) *to* silicon or germanium, while Group III elements are *acceptors* (of electrons) *from* these same Group IV elements. A glance at the Periodic Table will make these relationships clear. Another shift in viewpoint makes silicon or germanium recipients of electrons from the elements in Group V and of *holes* (lack of electrons) from elements in Group III.

The number of detachable electrons in the outer orbit of the atom is the same as the Group number of the element in this scheme of classification.

The peculiarity of Group IV elements lies in the fact that their outer orbits are half filled. They are neither strongly positive elements like those in Groups I, II and III, with one, two or three detachable electrons, nor strongly negative elements like those in Groups V, VI, VII and VIII, whose negative valence comes from lack of electrons to complete the stable shell of 8.

A further peculiarity, beyond that of electron structure in the atom, must be responsible for the great differences shown by materials in their ability to conduct an electric current. Some metals, especially silver, copper, and aluminum are good conductors. Others, especially alloys such as Nichrome, display great resistance to passage of the electric current. They develop heat because of this resistance, so that they are used in heating devices.

But metals in general are conductors, and the differences between them are not great compared to the electrical resistivity of those substances known as insulators. The energy necessary to drive an electric current through a good insulator is enormously greater than that used with a metallic circuit. Scientists are measuring

➤ EXPERIMENTAL *radio transmitter built by Everett Read of General Electric is housed in the tiny cylinder shown here and operated by the germanium transistor shown beside it. It has a broadcasting range of several hundred feet and is believed to foreshadow many new small-scale electronic devices.*

such materials and mapping the structure of solid materials, in terms of energy, by means of such measurements.

Semiconductors occupy a range in between the conducting properties of metals and of insulators. They may be as varied in chemical nature as cuprous oxide, silver sulfide, germanium, silicon, and silicon carbide The current they carry may vary from specimen to specimen of the same material, or from time to time in the same specimen, depending upon heat treatment of the sample, upon content of impurities, or upon imperfections in the crystal structure.

Pure, homogeneous crystals are naturally better conductors than are those in which the passage of electrons is interrupted by irregularities. A clever way of removing the impurities which cause many of these irregularities was developed in 1952 by W. G. Pfann of Bell Laboratories. He passed a billet of germanium metal through a loop of hot wire. The metal melts where it is surrounded by the wire. As the billet moves at right angles to the loop the melted zone passes along the length of the metal and sweeps impurities along into one end of the billet. The end of the billet where they collect is then sawed off. The process has been applied also to silicon as part of its refining process.

But although crystals of these semiconducting materials should be very pure in order that the crystal structure may be regular, minute amounts of elements from the neighboring groups of the periodic table should be present, as explained above, to assure the electronic imbalance which speeds the current in one direction and blocks its passage in the other. Atoms of these elements belonging to Groups III and V have been created in germanium by nuclear transmutation, and the resulting effects measured. Semiconducting properties have also been modified by addition of minute amounts of the proper neighboring elements, a process known as "doping".

However the presence of the neighboring elements is assured, the fundamental mechanism of semiconductors as now understood depends upon the presence of a small amount of a Group V element, or else of a small amount of a Group III element in a quantity of a Group IV element such as germanium.

Since the Group V element has one extra electron, a semiconductor of this type is an "n" type conductor, the "n" meaning *negative*, for the charge of the electron.

Similarly, since the Group III element has one electron too few to match the electronic structure of the surrounding germanium atoms, material containing a trace of such an element forms a semiconductor of the "p" type, the "p"

meaning *positive*, for the charge due to lack of an electron. In material of this sort, the conductivity is said to be by "holes."

The practical application which sparks much of the present interest in the rather abstruse theory of semiconductors is the saving of space in electronic equipment when a tiny junction based on a spot of germanium takes the place of an electron tube. The illustrations accompanying this article show miniature parts which are now coming to be standard for new types of equipment. As progress in theory of semiconductors shows the way to create new materials with predictable properties, progress in this direction may well show how to use radiation now considered too weak or too diffuse. Application of solar power and of atomic batteries are among the fields awaiting adaptation of such electronic devices.

On the Back Cover

➤ ULTRASONIC *etching produced this bubbly surface on germanium in the Research Department of Bell Telephone Laboratories. Scientists there are interested in the effect of imperfections in germanium crystals on semiconducting properties.*

Men Eat DDT For a Year

➤ FOR A FULL year, 14 men voluntarily ate DDT, famous insecticide, to test its safety. Some of them ate every day 200 times the amount an average person gets from his diet through the residue left on fruits and vegetables sprayed with the insect killer.

The DDT came through this safety test with flying colors. During the entire test none of the volunteers complained of any symptoms or showed any sign of illness which did not have an easily recognized cause clearly unrelated to exposure to DDT.

The study was reported by Drs. Wayland J. Hayes Jr. and William F. Durham and Cipriano Cueto Jr. of the U.S. Public Health Service, Savannah.

DDT, as has been known for years, is stored in the body fat. The maximum storage is achieved in about one year apparently. After that no more is stored in spite of continued intake.

The scientists concluded that "there is a large safety factor associated with DDT as it now occurs in the general diet."

Use Radio Telescopes To Search For Unseen Materials

Matter Revealed by Radio Waves

➤ UNSEEN MATERIALS in the space between the stars will be searched for by giant radio telescopes now being built or planned.

Scientists attending the American Astronomical Society meeting recently learned of the new, exciting possibilities from studying the heavens by radio waves rather than light waves.

Large receivers have been used to pick up radio waves of two gases in interstellar space, hydrogen and deuterium, hydrogen's heavy twin. They were found at a wavelength of 21 and 92 centimeters, respectively.

Other materials for which search will be made include a carbon-hydrogen combination at a wavelength of several centimeters and an oxygen-hydrogen grouping at about ten centimeters.

Radio astronomers are also searching for individual objects they can isolate by their absorption of certain energy bands in radio wavelengths, just as optical astronomers now analyze a star's composition by absorbed light. Only one has yet been discovered.

Radio waves in the middle of standard AM broadcasts have wavelengths of about 1,000 feet. Those used by radio astronomers in looking for now-hidden materials in interstellar space are measured in inches.

One new radio telescope, which will be about 700 feet long and 75 feet high when completed in two years, is being constructed at Ohio State University at Columbus. The scale model built on a rooftop to test design principles has worked so well it is now being used as a research instrument, Dr. John D. Kraus reported to the meeting.

Heavens Mapped by Radio

➤ A MAP of the heavens as it appears from radio waves rather than light has been made by Ohio State University astronomers.

Dr. H. C. Ko told the American Astronomical Society meeting that the new, detailed map covers 70% of the sky, and is the most complete yet made. It shows the distribution of radio waves of 250 megacycles from the celestial sphere visible at Columbus.

The map's most prominent feature is the Milky Way galaxy, the disk-shaped pinwheel of billions of stars in which the sun and its planets are located near an outer edge.

Reach Stellar Temperatures

➤ STELLAR temperatures, about three times as high as those of the sun's surface, have been reached momentarily in the laboratory, a University of Michigan physicist has reported.

Dr. E. B. Turner told the American Physical Society meeting in Pasadena, Calif., the 15,000-degree temperatures were generated in a shock tube, after a diaphram separating gases under extremely high and low pressures was broken.

Shock waves, because of the stellar-like temperatures they generate, have been suggested as a method of triggering hydrogen bombs without exploding an atomic bomb. Doing so might be one way of building baby hydrogen bombs.

As a high-pressure gas rushes into a low-pressure zone, a powerful shock wave is produced. In the University of Michigan instrument, it moves along the 12-foot tube at 10 to 20 times the speed of sound.

Since heat is the energy of atoms in motion, the violently agitated gas particles in the shock wave's wake reach incredibly high temperatures for an instant.

This heat is partially dissipated in the form of brilliant light, then is quenched by the cool "pushing" gas. So short-lived is the shock wave it does not have time to heat the walls of the tube.

By observing the characteristic light, or special lines, of the excited atoms at one end of the shock tube, physicists gather data under known conditions that can then be used by astronomers to check their interpretations of stellar spectra.

Present experiments center around the spectral lines of hydrogen, a major component of nearly all stars, including the sun. These lines vary in brightness and shape, depending on conditions at their source.

Dr. Turner told the Physical Society's division of fluid dynamics they have now obtained quantitative measurements on spectral line shapes, using a revolving drum camera.

Dr. Turner said the shock tube will be valuable in helping to determine the amounts of elements present in the stars. Although now astronomers can tell what elements are present, there is no reliable way to measure the quantity.

Window For Studying Heavens

➤ A NEW "WINDOW" through which to scan the heavens has been discovered by one of the scientists who pioneered development of radio astronomy.

The just-discovered "hole" in the earth's atmosphere lets radio waves from outer space pierce to the surface, where they can be detected by sensitive radio receiv-

ers tuned to frequencies between one and ten megacycles.

It is the second gap in the atmosphere for radio wavelengths. The first, widely studied since the end of World War II, covers radio waves from about two-fifths of an inch to about 32 feet.

Grote Reber, working in Australia with assistance from the Research Corporation, New York, calculated where he thought the new atmospheric window might be easily observed, then set up his equipment in Hobart, Tasmania, to search for it. G. R. Ellis of the Commonwealth Observatory in Hobart, Australia, worked with Mr. Reber in the study.

The hole occurs where an invisible line of the earth's magnetic field cuts the surface. These lines are parallel to the surface at the equator and dip in at greater and greater angles toward either pole from there.

In Tasmania, Mr. Reber found, radio receivers aimed at an angle of about 30 degrees were looking along one such line right through a hole in the ionosphere, the earth's radio-reflecting layer high in the atmosphere.

Using radio waves to study the universe has been possible only for about 20 years, and extensively only in the past 10. Until then practically all knowledge of objects beyond the earth came from observations of light.

Both light waves and radio waves are electromagnetic waves, differing only in wavelength. The earth's atmosphere shuts off most electromagnetic waves, except for the two regions of radio waves and light waves, as far as is known.

Electronics to Stretch Telescope

➤ TELEVISION principles applied to telescopes can make a 2,000-inch telescope of the 200-inch giant atop Mt. Palomar in California, the world's largest instrument. This would let astronomers look three times farther into space than is now possible.

This will happen only if the electronic device, called the "image converter," works perfectly. Development of such a device is the goal of astronomers and physicists working at several institutions in the United States and Europe.

Astronomers using any telescope equipped with the ideal image converter would be able to study stars only one-tenth as bright as the faintest they can now see with unaided photography.

Even if the electronic photography method does not work perfectly, gaining only part of the expected increase in sensitivity would be worth the "all-out effort" astronomers are making to develop image converters.

Urea has the highest nitrogen content of all solid fertilizers.

New Chemical Weapons
In Fight Against Cancer

New Directions in Cancer Therapy

➤ A POSSIBILITY of forging an anti-cancer weapon from the fruit fly's "growing-up" hormone appears in studies by Dr. C. H. Haddox Jr. of Louisiana State University Medical School.

Cancer is generally considered a condition in which cells fail to grow up and become specialized.

The hormone is called pupation hormone by scientists. It is produced in ring glands near the mouth of the fruit fly and changes larvae into the adult stage.

Flies with no growing-up hormone develop large abdominal pigmented masses resembling the black cancers called melanoma in man. Flies with ample production of the hormone do not develop these tumors, Dr. Haddox found. Flies given the hormone during their change to adults built hard restraining capsules around the tumors. Tumors stopped by the hormone grow rapidly when removed from the animals and placed in tissue culture lacking the hormone.

Dr. Haddox is now trying to get enough of the growing-up hormone to test it on mice with cancer. It can be extracted from flies and moths, but it takes several pounds of the insects to yield enough hormone for a few experiments.

The findings were announced by the American Cancer Society which supported the work. Collaborating with Dr. Haddox was Dr. Walter Burdette, now at the University of Missouri, Columbia.

Two Anti-Cancer Chemicals

➤ CHEMICAL WARFARE against cancer is advanced by two chemicals recently announced. Both have been tried in animals but so far no human trials of either are reported.

One is a counterfeit of a protein-building amino acid. It is called TA, short for B-3-thienylalanine. It was synthesized by Dr. Karl Dittmer of Florida State University. Drs. Edgar C. Bristow 3rd and Robert W. Wissler at the University of Chicago and the Argonne Cancer Research Hospital, Chicago, find it a "gentle drug" which can be taken by mouth and which slows down the growth of transplanted rat tumors.

A widely used flavoring agent, mono-sodium glutamate, and a very poisonous, flammable and explosive gas, diazomethane, have been used to synthesize the other hopeful chemical against cancer, called D.O.N.

D.O.N. is short for 6-diazo-5-oxo-L-norleucine. Scientists at Sloan Kettering Institute for Cancer Research, New York, found it 30 times more effective in the control of tumors in mice than is azaserine. Azaserine is an antibiotic, or so-called mold remedy, tried earlier as an anti-cancer remedy in experiments by the Sloan-Kettering group.

D.O.N. was synthesized by scientists at the Mellon Institute, Pittsburgh, and at Parke, Davis and Company, Detroit, and was also produced by fermentation methods by scientists at the Detroit firm. It was reported at the meeting of the American Chemical Society in Dallas.

The basis for hope that D.O.N. may prove useful in the treatment of some types of tumors lies in the finding that, as well as inhibiting the mouse tumor, the product has been found to inhibit a fundamental biochemical process, the formation of nucleic acids from smaller chemical fragments, scientists reporting D.O.N. said.

Test 2,000 Possible Drugs

➤ THE U.S. Public Health Service has contracted for testing before July 1 some 2,000 chemicals as anti-cancer drugs, Surgeon General Leonard A. Scheele has announced.

Each chemical compound will be tested against three different kinds of cancer implanted into various strains of mice bred for cancer susceptibility. The procedures for this screening test for possible anti-cancer drugs were established by the Cancer Chemotherapy National Committee.

The tests will be carried on in the following laboratories: Microbiological Associates, Bethesda, Md., Wisconsin Alumni Research Foundation, Madison, Wis., Southern Research Institute, Birmingham, Ala., Hazleton Laboratories, Falls Church, Va., and Stanford Research Institute, Menlo Park, Calif.

At present, Dr. Scheele points out, the only cancer cures are achieved by surgery or radiation, but some forms of cancer, such as acute leukemia, are not amenable to these treatments. Other forms may be diagnosed only after they have spread throughout the body, too late to be benefited by either surgery or radiation. In such cases, chemical treatment appears to offer the greatest hope.

Chemical Basis for Wasting

➤ A CHEMICAL basis for the wasting away of cancer patients, with implications for treatment in the future, has been found by Dr. Jere M. Bauer of the University of Michigan, the American Cancer Society which supports his research has announced.

In mice, the wasting of cancer is accompanied by loss of protein and of a body chemical called glutathione. This chemical is an oxygen carrier and has been re-

ported to play a role in the body's manufacture of protein.

Dr. Bauer's mice lost about a third of the protein of their bodies and more than a third of the glutathione by the time transplanted cancers had grown to a large size.

They also lost about a half to three-fourths of the fat found in a healthy mouse on the same diet.

The findings of Dr. Bauer's work tend to challenge one common concept — that the body of the cancerous animal contains increased amounts of water. The Michigan experiments show that although the percentage of body water does increase during tumor growth this is largely due to the excessive loss of fat and does not represent a true increase in water content of the body tissues.

When the basic effects of malignant growth on the metabolism of the body are known, the influence of treatment by changes in diet, X-ray, and surgery will be determined. Such an approach may give more objective criteria for evaluating the effects of cancer therapy.

Electric Charge Difference

➤ DIFFERENCE in the electric charges carried by normal cells and cancer cells have been discovered by Dr. E. J. Ambrose of the Chester Beatty Research Institute and Royal Cancer Hospital, London, and Drs. A. M. James and J. H. B. Lowick of the Chelsea Polytechnic, London.

The discovery may give a new approach to chemical treatment of cancer and let scientists launch an attack on the cancer cells without damaging normal cells, the scientists pointed out in a recent report to the scientific journal, Nature.

The average electrical charge density of kidney cancer cells from hamsters is almost twice that of the normal kidney cells from which the cancer cells developed, the scientists found.

A similar difference was found for liver cancer cells and normal liver cells.

The scientists think the differences may be due to one of two things: 1. A change in the number of charged groups attached to high-molecular weight material, such as carboxyl-rich chains of protein. 2. A change in the ability to absorb positive ions. The second is considered more likely because cancer tissues show a decreased calcium content in comparison with normal tissues.

The findings followed investigation of an earlier finding, by another scientist, that normal cells in tissue culture affect each other's movements by contact inhibition. Cancer cells do not show this inhibition with respect either to each other or to normal cells.

The difference is believed due to a loss of adhesiveness or sticki-

ness of the surface of cancer cells during their transformation from normal to cancer. This suggested that the electrical properties of the cell surface might have changed during the cancerous transformation. The new findings show that this is the case.

Mold Drug, Viruses

▶ ANTIBIOTICS, or so-called mold drugs, and viruses are now being used in the fight against cancer, Dr. John R. Heller, director of the National Cancer Institute, Bethesda, Md., states.

One mold remedy, called actinomycin-D, is one of thousands of chemicals being screened for possible use in treating cancer. It has not yet been tried in patients but some preliminary evidence at the preclinical stage suggests the usefulness of this drug, Dr. Heller said in a statement to the subcommittee on appropriations of the House of Representatives.

The viruses have reached the stage of being given to patients at the Clinical Center at Bethesda. The ones being tested are some of the APC viruses which cause illnesses like common colds.

Patients getting the virus treatment had been treated by other methods without avail. The viruses were injected first into the cancer, then into the patients' blood stream, and finally injections were given both into the cancer and into the blood stream. The cancers were damaged, but unfortunately the patients began building resistance to the viruses, after which they no longer were effective against the cancer.

The hope now is to find some way of concentrating the virus agent or of discovering other, cancer-destroying viruses against which the patient does not build resistance.

Hope of developing a blood test for detecting early cancer comes from another study reported by Dr. Heller. In this study scientists found that women with advanced breast cancer have abnormally high proportions of large molecule fatty chemicals and low proportions of small molecule fatty chemicals, as compared to the proportions in the blood of normal women. This finding, Dr. Heller said, may be a potential aid in developing blood tests for early cancer.

Weed-Killer for Research

▶ A NEW TOOL in cancer research may be a chemical now used as a weed killer and cotton defoliant.

Dr. Werner Heim, Dr. David Appleman and H. T. Pyfrom of the University of California at Los Angeles College of Agriculture have discovered that weed-killing amino-triazole has the same effects as cancer on the body enzyme known as catalase.

This identical action of aminotriazole and cancer on catalase promises new clues to the biochemistry of cancer.

Fission Products, Reactors, New Particles, Objects of Study

Tin Puzzling as Reactor Product

➤ ATOMIC PILES of the future may be able to run without becoming clogged by fission-produced by-products, including tin, if research now underway in Michigan State University's chemical laboratories succeeds.

Dr. Carl H. Brubaker Jr., assistant professor of chemistry is studying how the tin atom changes from stannous to stannic form in an effort to determine the exact nature of tin and tin compounds.

Dr. Brubaker's study concerns the fundamental nature of the tin atom. He uses a spectrophotometer, that gives some indication of the nature of the change from stannous to stannic form by measuring the amount of ultraviolet light transmitted through or absorbed in the solution at various states.

An Atomic Energy Commission grant supports Dr. Brubaker's project. The A.E.C. is interested in tin because of difficulties in eliminating by-products from atomic piles.

Tin is one of about 34 elements produced by atomic fission. If these elements are not removed, the uranium becomes clogged and diluted, causing the pile reaction to stop.

In dry atomic piles, it is usually possible to pull out a little contaminated uranium at a time, remove the tin and other by-products, reprocess and reinstate the uranium—all without stopping the pile.

In piles run in solution, it was originally necessary to stop the reaction completely to remove the tin. Now scientists often pump in new solution while pumping out old, without stopping the reaction. This does not completely remove by-products and eventually liquid piles must be stopped and impurities eliminated.

Atomic chemists want not only to remove radioactive tin from piles, but to remove it in a pure state so it can be used in tracer experiments. Tin recovered from an atomic pile is purer and easier to work with than is natural tin, which is often associated with other elements that confuse experiments.

Radioactive tin is used for metallurgy research to study tin compounds, for tests on tin corrosion and to study changes in the tin atom.

Dr. Brubaker also has thermostatic baths and refrigerated equipment to measure effect of temperature in inducing chemical

reactions. The baths are accurate within 1/200th of a degree Fahrenheit. When gauges indicate temperature is about to fall, powerful infrared lamps flash on.

Surprisingly little is known about tin which, in its stannic form, has a valence of four. Its valence in stannous form is two. Chemists have never been able to learn exactly what happens when the element changes from one form to the other.

Super Atom Smashers

▸ A SUPER atom smasher to hurl hearts of hydrogen atoms at each other with energies nearly 200 times the highest now available is in the planning stage.

Bigger and more powerful machines to speed up the elementary particles of which atoms are made were a top topic at informal sessions among scientists attending a nuclear physics conference at the University of Rochester recently.

Suggested name for the proposed accelerator is the "synchroclash." It would actually be two machines whose atomic bullets smack head on into each other, instead of the single beam crashing into a stationery target as in present machines. This could give protons energies of 1,000 billion electron volts or more.

Plans for such a super atom smasher are being studied by Midwestern Universities Research Association, composed of 20 universities.

Particle accelerators now under construction or planned have about reached the upper size limit, and scientists are being forced to use "tricks" to reach higher energies.

One trick is to use a very complicated magnetic field, known as alternate gradient, for focusing speeding particles. The higher the energy, the closer a particle is to the speed of light, limiting velocity according to Einstein's theory of relativity.

The three Russians who attended the Sixth Annual Conference on High Energy Nuclear Physics revealed Soviet plans for building an accelerator to reach 50 billion electron volts, or 50 BEV, using this principle.

CERN, a joint enterprise of 12 European nations, and Brookhaven National Laboratory on Long Island are now building atom smashers that will operate at 25 billion electron volts, also using the alternate gradient idea.

The newest trick is to smash one bunch of high velocity particles into another group of speeding atomic fragments, as in the synchroclash. And if two atom smashers, each accelerating protons to 15 billion electron volts were built and a bunch of hydrogen hearts from one were aimed at the other, the resulting collision would produce the equiva-

lent of 1,000 billion volts in energy.

An accelerator operating now reaches the highest energy in the University of California bevatron with a top energy of six billion electron volts. The first authentic example of anti-matter, the anti-proton, was discovered in this machine last fall.

Russian scientists expect to have a 10 billion volt machine operating within a year.

Scientists build atom smashers with higher and higher energies to create and study new particles, as well as to examine those already known in more detail.

Cosmic rays, atomic radiation continually smashing into the earth's outer atmosphere, result from the most powerful accelerator known — whether from the sun, other stars, our Milky Way galaxy or the universe itself is still to be determined.

Man-made machines are now beginning to duplicate the lowest part of cosmic rays' energy range.

Other particles of anti-matter will probably be discovered as the new U.S. and Russian accelerators now being built start operation.

Salvage Fission Products

➤ ATOMIC POWER is a chemical business. Manufacture of power as a by-product may lead chemical industry into new fields for the sake of chemical transformations brought about by atomic radiations, Dr. Willard F. Libby, member of the U.S. Atomic Energy Commission, forecast in an address before the American Power Conference.

Intense radiation is so successful in producing polymerized materials and in sterilizing drugs and pasteurizing foodstuffs that these may become the most important functions of atomic reactors in the future, Dr. Libby believes.

Tremendous quantities of waste heat from atomic reactors could be put to work economically by chemical plants now buying fuel to make their chemical operations go, Dr. Libby believes. He stressed the need for good chemists in the employ of industry.

Opportunity for developmental work in atomic energy, both for power production and for better use of fission products, now chiefly a nuisance, will increase both in America and in other parts of the world, Dr. Libby stressed. He pointed out that the "break-even" point in competitive A-power very likely will be attained sooner in Europe and in Asia than in the United States. The situation is tailor-made for an industry which still requires some developmental work and reduction to practice. The market for A-power exists and should find ready acceptance.

Wood chips, sawdust and other types of wood fragments are beneficial to the soil, particularly where the texture is sandy loam or coarser.

Plan Water Re-Use
To Fight Shortage

Better Use of Water Sought

➤WATER to cover the United States to a depth of eight and a half inches is the upper limit of possible water resources development, members of the American Chemical Society were told recently by Dr. K. A. MacKichan of the U.S. Geological Survey.

Speaking at a symposium on re-use of water by industry, Dr. MacKichan pointed out that increased industrial use and increased irrigation combine to increase use of water at a very rapid rate at the present time. Using the estimate of 170,000 million gallons of water per day withdrawn from the ground, lakes and streams in 1950, Dr. MacKichan stated that this was less than 15% of the theoretical total. However, the speaker observed, "not all this water is available at the time or place that it is needed."

Water power accounted for an additional 1,100,000 million gallon of water per day, Dr. MacKichan said, although some of the water counted in these estimates was used more than once and so counted more than once. The geologist's conclusion was that water for further industrial development is available, but that cheap sources of it have already been developed. Increased cost for additional supplies will force more extensive use of waste-water and recycling of water used in industry.

Examples of successful economy in water use by industry were cited by Dr. L. F. Warrick, U.S. Public Health Service, Washington, D.C., who found encouragement in the fact that manufacturers have recognized the need for conservation of water resources and are meeting the challenge.

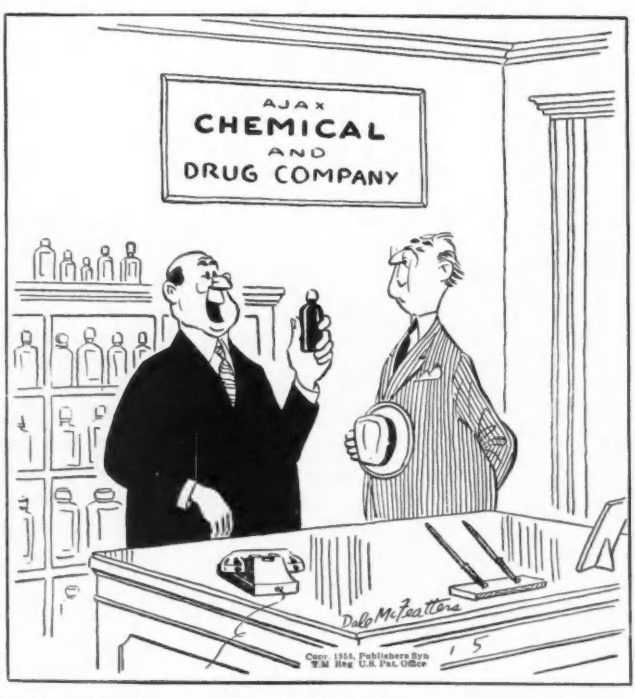
Problems in avoiding corrosion when water condensed from steam plants is re-used were outlined by H. M. Rivers and D. E. Noll of Hall Laboratories, Inc., Pittsburgh, Pa.

A trend toward use of less water by the pulp and paper industries was seen by Howard B. Brown of the National Council for Stream Improvement, Inc., Pulp, Paper and Paperboard Industries, Inc., Baton Rouge, La.

Atomic Energy Commission plants have special requirements because mineral compounds dissolved in coolant water may become radioactive, adding to the amount of shielding required around the piping system. Demineralizing installations are necessary to produce the required

degree of purity in the water used, Dr. A. L. Biladeau, U.S. Atomic Energy Commission, Idaho Falls, Idaho, told the chemists. Water conservation is very much in evidence in all U.S. AEC installations, he stated, adding that in some of the plants an additional demineralizing treatment is used to keep radioactivity of the water down to an acceptable level. The ion exchange resins used for this last treatment are not regenerated, Dr. Biladeau explained, but are thrown away in a procedure of special handling for safe disposal of radioactive wastes.

Control of algae and bacteria in water used in petroleum refining, and in sewage treatment to make water fit for industrial use, and biological fouling in recirculating cooling water systems were also discussed at the meeting.



➤ "Now *here's a real 'miracle' drug! We were almost bankrupt when we discovered it!*"

For The Home Lab

Glucose

➤ OF THE MANY types of sugars known to the chemist the two most familiar are cane sugar, or *sucrose*, and grape sugar, or *glucose* (dextrose). We have already investigated sucrose (CHEMISTRY, Feb. 1956); now we will consider glucose.

Glucose is a *monosaccharide*, or simple sugar, with the formula $C_6H_{12}O_6$. It occurs in the juices of many fruits and in honey.

Glucose can be obtained by the hydrolysis of a disaccharide sugar or starch. We performed the former reaction in our experiment on sucrose. So, now suppose we try the hydrolysis of starch. Mix 2 grams of ordinary corn starch with 25 cc. of water in a mortar. Grind with the pestle until a smooth suspension free from lumps is obtained. Pour the mixture, with stirring, into 235 cc. of boiling water. Continue stirring for a few minutes and allow to cool. Pour 25 cc. of this solution into a beaker and add one cc. of concentrated hydrochloric acid. Boil the solution gently. From time to time test a small portion of the liquid with iodine test reagent (a very dilute solution of iodine crystals in potassium iodide — liquid should be straw-colored). When the test portion no longer turns blue with iodine, discontinue heating and neutralize the mixture with sodium carbonate solution. Add one portion of the neutralized solution to Fehling's or Benedict's solution (see below) and heat to boiling. Note the brownish precipitate of cuprous oxide formed, indicating the presence of glucose. Pour another portion of the neutralized mixture into an evaporating dish and heat over a low flame until a syrupy liquid is obtained. This is a form of "corn syrup", although not for human consumption!

Glucose is a reducing sugar, which is the reason it reacts with Fehling's Solution to produce cuprous oxide. Add dilute potassium permanganate solution to glucose solution and heat. Note the color change, as the permanganate is reduced (or, conversely, the sugar is oxidized). For another example, prepare a solution of silver nitrate. Add just enough ammonium hydroxide to re-dissolve the precipitate that forms at first. When glucose is added to this reagent, a black precipitate is obtained and you will observe a thin film of metallic silver on the walls of the tube.

When glucose is boiled with concentrated sodium hydroxide solution, a dark yellow color is formed with a caramel-like odor.

This result, known as "Moore's Test", is due to changes caused by condensation and decomposition reactions.

Actually, glucose is acidic. To demonstrate, prepare a *dilute* solution of lime water (by dissolving calcium hydroxide in water and decanting). Add a drop of phenolphthalein solution to produce the characteristic pink color. Upon adding glucose, the pink color gradually disappears and the alkaline solution is "neutralized" by the glucose. Glucose reacts with calcium oxide to form calcium glucosate, which is soluble in water. In this role it acts the part of an acid. With acetic anhydride, glucose forms glucose penta-acetate. In this role it acts the part of an alcohol.

When we treat sucrose with hydrochloric acid we obtain glucose and fructose. How about when we treat glucose with acid? In this case a compound known as hydromethylfurfural is obtained. Heat a solution of glucose with a little hydrochloric acid to boiling for about 5 minutes. In another tube dissolve a few crystals of resorcinol in hydrochloric acid and mix the two solutions. A bright red color is produced.

When taken internally, glucose passes in the body without change and through the walls of the intestines into the blood. Hence it is sometimes called the "quick-energy" sugar. However, under certain conditions, such as in *diabetes*, the body is unable to assimilate glucose and the sugar must be eliminated through the kidneys. The presence of glucose in the urine is therefore a prominent symptom of the disease. There have been many tests devised to detect glucose in urine. The most common is to add Fehling's solution and boil, as described above. Here are a few confirmation tests: (1) Prepare a concentrated solution of lead acetate and a dilute solution of copper acetate. Mix the two and add to the solution containing glucose. On boiling, a yellow precipitate confirms the presence of glucose. (2) Boil the solution to be tested with a few drops of ammonium molybdate and potassium hydroxide solutions. Then add a few drops of hydrochloric acid. A blue color is obtained if glucose is present. (3) Boil about 16 cc. of the urine to be tested with ¼ gram ferrous sulfate and ½ gram potassium hydroxide. A dark-green to black precipitate indicates the presence of glucose.

The first vitamin to be synthesized, vitamin C (ascorbic acid), is obtained by using glucose as the starting point. First the glucose is converted into sorbitol by electrolytic reduction. Next the sorbitol is fermented to obtain L-sorbose. Finally, the L-sorbose is oxidized to sorburonic acid which is then converted to vitamin C by heating with water in

an atmosphere of carbon dioxide. There is a nice project for you if you would like to attempt it some evening!

The chemistry of sugars is a complete study in itself. The multitude of sugars and their derivatives add to the complexity of the subject. But the greatest mystery of all still remains unsolved — photosynthesis. How does Nature produce complex sugars from air, water and light?

Test Reagents

Fehling's Solution Fehling's test reagant consists of two solutions which are kept separate until ready for use. They are then mixed in equal volume and added to the solution to be tested.

Solution No. 1 - Dissolve 1.5 gram of copper sulfate in 50 cc. of water.

Solution No. 2 - Dissolve 8.5 grams of Rochelle salt (sodium potassium tartrate) in 10 cc. of warm water. Add a solution of 2.5 grams sodium hydroxide in 10 cc. of water. Finally, dilute the mixture with 30 cc. of water.

Benedict's Solution. Benedict's solution is a modification of Fehling's. Only one solution is required. Dissolve 10 grams of sodium citrate and 6 grams anhydrous sodium carbonate in 50 cc. of hot water. Add slowly, stirring constantly, a solution of 1 gram copper sulfate in 10 cc. of water. Filter the resultant solution.

Chill Gas to Make it Burn Hot

▸ How to enrich natural gas by making it poorer in non-burning nitrogen is being studied by the Institute of Gas Technology, affiliated with the Illinois Institute of Technology.

Nitrogen, the inert gas which makes up 78% of our atmosphere, makes its way into reserves of natural gas, the Institute finds. Energy is required to pump this non-burning gas through the pipelines which furnish fuel to customers at long distances from the gas wells.

Less energy would be required, the Institute's studies indicate, to cool the natural gas to the temperature where the hydrocarbon part would condense to a liquid. This temperature, for the experimental mixtures studied, was around 125 to 150 degrees below zero Fahrenheit. Nitrogen, remaining as a gas, could be pumped out of the pipeline. Natural gas fuel, enriched in percentage of burnable material by losing the nitrogen, could then be warmed up and sent through the distribution system.

Results appear under the title "Thermodynamic Properties of Methane-Nitrogen Mixtures," as Research Bulletin 21 of the Institute of Gas Technology.

➤ EMBEDDING RESINS *for biological specimens were the materials studied by John Bell Clark,* 18*-year-old senior at Sycamore High School, Sycamore, Ill., second-place winner in this year's Science Talent Search.*

Science Talent Search Winners

➤ THE FIFTEENTH Annual Science Talent Search, like those before it, brought to Washington forty of the top young scientists of the United States, chosen by competitive examination from members of the senior class of the secondary schools all over the country. As part of their entrance requirements, each had carried out an original study of some scientific project of his or her choice. The

▸ How POLYGONS *pack together in space-filling designs was the project of Robert Thorpe Moore, 17, senior from Montgomery Blair High School, Silver Spring, Md., who won first place in the Science Talent Search.*

Display Their Research Projects

variety of these projects and the originality with which the young people approach them is always an inspiration to the judges of this contest and to the Washington scientists who come to talk shop with the winners the evening they put on their exhibition. Extracts from the research reports of this year's winners, whose pictures are shown here, are printed on the following pages.

Improved Enbedding Resin
For Biological Specimens

Polyester Embedding Resins

by JOHN BELL CLARK

➤ UNTIL recent years, preservation of biological specimens has been limited to either dry mounting or immersion in volatile preservative liquids. Both methods have disadvantages including fragility, permeability, loss of color, vulnerability to the attack of organisms, and general nonpermanence of the preserved materials. The greatest advance in this field was the embedment of scientific specimens in transparent plastics. This method patterned nature's example of embedment of objects in amber.

Acrylics, owing to their extreme clarity, were the first plastics to be used for this purpose. However, newer, more effective synthetic resins have been developed. In 1937 and 1939 Kropa and Bradley published results of synthesis of polyester drying resins which could be polymerized with vinyl or other monomers to form insoluble, clear, hard resins. In the early 1940's Gerhart compounded and patented several polyester-styrene resins suitable for embedment purposes. At about the same time, Fessenden and Sando were investigating the technique of plastic embedment using methyl and ethyl methacrylates. This and other research was interrupted by World War II and was never resumed on a comparable level. Furthmore, the literature does not report extensive research on vinyl, polyester, and other embedding agents. Although some further research has been done and several embedding resins are available commercially, present materials and techniques are yet somewhat inadequate and many unexplained phenomena still exist. These shortcomings include:

1. Necessity for heat cures with their deleterious effects on specimens.
2. Presence of color toners in the resins.
3. High viscosity of commercial resins in monomeric state.
4. Inadequate polymerization catalyst systems.
5. Incomplete polymerization and chain termination resulting in yellowing of resin by oxidation upon aging.
6. Lack of precise methods of determining catalyst concentrations.
7. Loss of specimen color during preliminary conditioning or embedment.
8. Occurence of sheening and turbidity in the resin.

Insufficient diversity of prelim-

inary specimen conditioning processes to cover the wide variety of specimen types.

Most of these shortcomings arise from the absence of a comprehensive correlation of the chemistry, histology, and technique involved in plastic embedment.

As a consequence of these circumstances, I begin an investigative project to eliminate shortcomings, to develop new and improved methods, concepts, and materials, and to correlate the chemistry, histology, and technique involved in the various phases of plastic embedment ....

Before embarking upon the main parts of this investigation, I took the following preparatory steps which constitute a foundation and background for the preliminary investigation:

1. Survey of all current embedding techniques and available commercial resins.

2. Mastering of known techniques and the developing of new and original methods and processes.

3. Adaptation of improved embedding techniques to standard histological precedures.

4. Secondary investigations of the chemistry, properties and toxicology of monomers and other reagents involved.

5. Special investigation of the polymerization of vinyl, acrylic, and other monomers.

6. A series of individual controlled tests to determine the effect of prototype histological reagents upon styrene and its polymerization. These tests were designed to reveal solubilities, miscibilities, chemical action, acceleration, inhibition or prevention of polymerization, color changes, and effect on the properties of the resulting polymer.

Results of preliminary investigations indicated the need for a better embedding resin and need for further research in many phases of the field. A search of the *Chemical Abstracts* led to United States and foreign patents. Literary, analytical, and experimental research limited the field of possible resins to polyester-vinyl types. At this point, I began experimental synthesis of an improved resin. This initiated a search for the most effective monomer and unsaturated ester of a glycol and cis-trans acid. Ester synthesis after Kropa and Bradley with original modifications was used. I invented a mercury seal mixing rod for an inert atmosphere, esterification chamber. I also devised a thermostatic relay for a constant temperature oil bath.

After synthesis of possible esters was completed, one superior ester was selected for absence of color, functionality, and shelf life. The monomer was selected on the basis of absence of color, reactivi-

ty with polyester, and the hardness and toughness of the resulting copolymer. A copolymer was then selected from a field of thirty monomer-ester combinations. This copolymer was varied in proportions until an optimum composition was reached.

I then sought a room temperature cure using various initiator-promoter systems. Conjunctive systems were selected experimentally from a field of free radical yielding, polymer chain initiators (organic peroxides), metal driers (organometallic salts) and promoters (organic reducing agents). After selecting the most effective individuals from each group, forty combinations were tried and the most satisfactory system was isolated.

After four years of experience in polymerization and catalyzing resins, I began the formulation of mathematical relationships between seven physical and two chemical variables involved, governing catalyst concentrations and determining internal casting temperature or peak exotherm. Establishment of these relationships would eliminate a series of trial and error experiments.

Finally a method for preserving the color of the specimens was sought. Using a theory of color maintenance based on redox and pH control, I began a search for redox inhibited, dehydrating, surface active buffer solutions. Embedment would have no effect on color or appearance after immersion of tissue in these solutions. My current research involves use of these buffer preservatives and a search for other similar solutions.

Many of my observations have paralleled those of previous investigations, while considerable new and significant information has been discovered. As a result of the overview which investigation of the three involved sciences has afforded, some of the observations have added to or even contradicted previous information.

1. The polysters have surpassed the acrylics in effectiveness for most embedment purposes. Advantages of the polyesters include very high chemical resistance, hardness, toughness, absence of strains in the castings, low curing temperatures, low coefficient of polymerization shrinkage and low volatility.

2. Twenty-five distinctly different preliminary specimen conditioning processes, each adapted to a unique specimen nature, histological procedure, or special reagent, have been developed. Twenty of these are notably successful.

3. Catalyst systems of commercial resins were revised and their accuracy improved to yield more dependable results.

4. A new and improved polyester resin was synthesized. This is

a copolymer of styrene, triethylene glycol maleate, and maleic anhydride in which an alternate composition predominates. This resin has lower viscosity, yet no higher volatility, and better clarity than commercial resins and is completely curable at or below room temperature.

5. The most effective room temperature cure resulted from use of cumene hydroperoxide, a complex organic zirconium salt, and tertiary dodecyl mercaptan. The most efficient inhibitor proved to be tertiary butyl catechol. The benzene ring in cumene hydroperoxide absorbs ultra-violet light readily. This accelerates its decomposition into chain initiating free radicals. A shorter induction period and more rapid resin gelation can thus be obtained by ultra-violet excitation. The zirconium salt yields a harder resin by effecting more complete polymerization and chain termination. It also seems superior to other metal driers in overcoming the inhibitory effect of dissolved atmospheric oxygen in the resin. The mercaptan, through its reducing influence, aids in the decomposition of the hydroperoxide and greatly speeds up the reaction.

6. Using this cumene-zirconium-mercaptan system in optimum concentrations, a coolant bath, and ultra-violet initiation, a sample of the new resin gelled at atmospheric pressure in nine minutes. A complete time cure resulted in approximately three hours without addition of heat. The resulting copolymer was very hard and tough, unusually clear and colorless, free from bubbles, voids, and cracks and polished very easily to a high surface luster . . . .

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Crystals and Polymers Fill Space Like This

Packing of Convex Congruent Polygons

by ROBERT THORPE MOORE

▶ A STUDY of the problem of the packing of convex congruent polygons is roughly analogous to a determination of the possible shapes that the pieces of a jigsaw puzzle may have if they must be alike, straight-sided, and convex. The assembled puzzle is unbounded, and the number of polygons in it unlimited.

This problem is a special case of a larger one, the packing of polygons in general.

I have investigated the special case first because it is sufficiently limited to make a solution conceivable, although even this is potentially a very broad problem.

Fortunately the topological nature of networks makes the problem much more limited than it appears. On the basis of this nature networks, as expressed in special cases of Euler's general formula for polyhedra and the Lebesgue-Brouwer "tiling" theorem, I proved the following limiting theorem.

Theorem I: Convex congruent polygons will pack only if they have six or fewer sides.

The problem is thus limited to four types of polygons: triangles, quadrilaterals, pentagons, and hexagons.

To investigate the problem further it is necessary to formulate a method of proving whether or not a given polygon will pack. To serve this purpose I evolved and proved:

Theorem II: Any convex polygon which alone or combined with congruent polygons forms one large polygon made up of three pairs of opposite sides, such that the members of each pair are parallel and congruent, will pack.

This large polygon is often concave and thus at least one of its pairs of sides is made up of broken lines. Parallel, as used in this case, means that all the corresponding parts are parallel; and, combined with the congruent, means that the sides are translatable into one another without changing the orientation of the polygon; hence the name "oriented cell."

After having finished a good portion of this project, I learned that a proof of the oriented cell, somewhat simpler than mine, was evolved in crystallography research, using a non-cartesian coordinate system and vectorial sums in such coordinates. I am using mine, however, because it is my own work and it is proved by the

plane geometry techniques with which I am familiar.

Corollary A: The oriented cell packs as a hexagon made up of the vectorial sums of the parallel and congruent side pairs, such that these vectorial sums are parallel and equal.

Corollary B: A polygon with three pairs of sides such that members of each pair are opposite and properly congruent, and one pair parallel, is an oriented cell. (Properly congruent means that one member need not be turned on its back to be proven congruent to the other.)

It might be noted that although it is possible to prove that all polygons covered by Theorem II and Corollary B will pack, and that those not covered will not pack *in an oriented way*, it is not possible to prove that those not covered will not pack at all, without constructing a complete theory of the packing of concave polygons; and this last I leave to later years or wiser heads.

In order to study polygons and the manner in which they pack, it is desirable to develop a system, rather than to use mere random selection of subjects. The technique I have developed makes use of the fact that, in hexagon packings, exactly three polygons, thus three angles, must lie about any given vertex. Considering one vertex, there are seven sets of angle packings: (1) three successive angles about a point, (2) two successive angles and one alternate angle, (3) three alternate angles, (4) two like angles and a successive, (5) two like angles and one alternate, (6) two like angles and an opposite, and (7) three like angles.

My approach has been to consider each of these sets by placing the three prescribed angles about a point, then determining various sets of side equalities necessary for this packing to be possible. For each set I found that there are eight cases of side equalities to be considered. In some cases, I have found that it is necessary to consider four intersection points instead of one, in order to prove that the polygons pack. These four may be considered in a snowflake pattern. In several very stubborn cases, it is necessary to consider still more vertex intersections.

Using the techniques outlined in the last section. It is possible to generate packable polygons (If the technique is carried to enough steps). I have tried to place all of those generated in general classes, and have found and proved three.

The first packing grows out of set one and is quite general. The hexagon considered has one pair of opposite sides parallel and equal, and two of these hexagons may be combined to form an oriented cell. All set one hexagons are covered in this class. It might

be noted that if one unlimited side of this hexagon is of no length, a class of pentagons is generated. If the parallel and equal sides are both of no length, the class covers all quadrilaterals. If one of the sides of the quadrilateral is of no length, this class also covers all triangles. It is also the most general class, having a seven-fold infinity of polygons satisfying the conditions.

The second class grows out of set two, and has one pair of opposite sides equal, the two sides adjacent to one member of the first pair, and three particular angles adding up to 360°. Four of these make up an oriented cell. It is a more limited class than Class I, having only a six-fold infinity of satisfying polygons, and covers most of the set two packings which do not fit in Class I.

The third class grows from the third set, and has three separate pairs of adjacent sides equal, the angles included by these pairs of sides all equal to 120°, and three of the polygons make up an oriented cell. It covers two of the set three cases, the others being Class I polygons. It is a very limited class, having but a three-fold infinity of polygons.

This completes the classes I have thus far proved.

There is considerable scope for further study of this problem. I hope to complete the remaining studies as soon as possible and am currently following up several leads.

Three cases in set two remain to be fitted into one of the three classes. They seem to fit in Class II, but this is yet to be rigorously proved.

Sets four, five, six and seven still remain as raw material, and I have not yet completely investigated them, although many cases that I have thus far considered definitely do pack as one of the proven classes.

The pentagons also remain to be studied. Two pentagon classes have been proved: those which are special cases of the two hexagon classes with an unlimited side. However, because in pentagon packings more than three vertices may lie about a point, there may be special classes of pentagons to be studied.

The greatest challenge is to formulate a general law covering all packings of convex congruent polygons. I hope to meet this challenge eventually, or learn that someone else has done so.

If applications of this work are considered desirable, they may be found. (I do not feel that they are needed, however, since I enjoy solving a problem for the sake of solving it). In its three dimensional counterpart, this study is possibly relevant to crystallography and organic chemistry (high polymers), and may have applications to problems yet unposed. . . .

Chemical Developments Reported At Dallas Meeting of Society

Research Results in Chemistry

METALS such as magnesium, calcium and potassium, normally present in the food we eat, may be so linked with production of amino acid in plants such as beans and peas that lack of the metals stimulates the plant to make more amino acids.

Magnesium deficiency increases the amount of asparagine, Dr. John F. Thompson of the U.S. Plant, Soil and Nutrition Laboratory, Ithaca, N.Y., has found, while lack of calcium tends to increase the amount of aspartic acid produced by plants. Arginine, another amino acid, accumulates in plants which do not get their normal amount of iron.

Other chemical elements, such as zinc, boron and sulfur, also affect the compounds formed by growing plants. Plant proteins increase in plants grown in the light and at low temperatures, Dr. Thompson has found, and plants as they grow older tend to form less asparagine.

Dr. Thompson reported his findings to the Dallas meeting of the American Chemical Society. Other effects of metals on growth processes were reported at the same meeting in a symposium on the relation of environment to nutritive quality of crops.

Effects of soil deficiencies on growth of grazing animals have been recognized for some two thousand years, Dr. Kenneth C. Beeson, also of Ithaca laboratory, explained to fellow chemists, although the true cause of the trouble has only lately been understood.

Molybdenum may play a critical role in the chemical reactions which use the energy of sunlight to build up life chemicals in plants, Dr. Robert Van Reen of the Johns Hopkins University told the chemists, reporting on work on the role of minerals in enzyme systems, in which he was assisted by Dr. Alvin Nason.

Magnesium and manganese seem to lead the fields of metals involved in making enzyme systems work, in a study reported by Dr. Van Reen. Among the organic systems studied by his research team were some enzymes able to use one or another metals, such as zinc, mercury or cadmium, whichever are available. Understanding of the way these metals combine with living systems may advance the possibility of using photosynthetic reactions to produce food directly from inorganic chemicals.

Yields New Alkaloids

➤SNUFF from tree seeds was used by pre-Columbian Indians for the purpose of producing hallucinations. Modern efforts to identify the chemicals responsible for these weird effects on the senses have yielded new information on how the body breaks down the chemical tryptophan.

Reporting on work by Drs. E. C. Horning and M. S. Fish of the National Heart Institute, Bethesda, Md., Dr. Horning told the American Chemical Society's division of medicinal chemistry of analysis of three authentic samples of "yopo" or "cohoba" snuff. The powerful stimulant principle is said to come from seeds of Piptadenia peregrina and Piptadenia macrocarpa trees, and to belong to the chemical family of the alkaloids. One of the samples of snuff was brought from Brazil in 1882. The others are more recent, one from Venezuela in 1949, the other from Colombia in 1954-1955.

Analysis involving the chemical breakdown of the unfamiliar alkaloid along the expected lines of utilization of similar compounds by the body showed a pattern of occurrence of indole bases which led the Heart Institute chemists to suggest that they have found in this material a new route of tryptophan metabolism.

Indole alkaloids show a variety of unrelated effects on the body, Dr. Jurg A. Schneider, CIBA Pharmaceutical Products, Inc., Summit, N.J., reported to the same meeting. Some lower blood pressure and heart rate, others have the opposite effect. Indole itself is necessary for production of protein, Dr. Schneider stated.

Fat New Chemical Source

➤ FATS, which became too plentiful as detergents displaced soap on the market, are now in increasing demand as chemical sources in the manufacture of surface coatings, plastics, lubricants, cutting oils and even detergents themselves.

Treatment with nitric acid changes fats to materials taking an active part in a wide variety of chemical processes, making such products a "master key to the great variety of their industrial outlets." Such application was explained to members of the American Chemical Society by Dr. Miles R. McCorkle of Armour and Co., Chicago. Dr. McCorkle spoke at a symposium on industrial applications of fatty acids.

At the same meeting, Dr. Waldo C. Ault, Eastern Regional Research Laboratory, Philadelphia, told of the availability, cost and composition of animal and vegetable fats and tall oil as chemical raw materials. Dr. Ralph H. Potts, Armour Chemical Division, McCook, Ill., described continuous processes, automatically controlled, for converting fats from such sources into a variety

of chemical products. He stressed the proper materials to be used in these automatic plants to avoid corrosion by fatty acids formed.

Chemical Rain Repellent

➤ A CHEMICAL rain repellent that eliminates mechanical windshield wipers was demonstrated to the American Chemical Society.

Designed for high speed jet aircraft, the repellent is made of silicones and a combination of natural and synthetic waxes. The coating is applied to the windshield in two steps that take about 15 minutes. It will last for several days of heavy rain, after which time the windshield is cleaned and recoated.

Although primarily designed for military aircraft, the repellent has commercial value and will be put into operational use by United Air Lines.

The chemical rain protector sets up a hard coating on the window pane that makes rain roll off like heavy beads of mercury. The wind and speed of the airplane also help to sweep the rain drops away.

It is not adaptable for automobiles, it was reported, because of the slow speed of cars. It may have further application to eliminate salt spray encrustation on speed boats, however.

The repellent is the result of four years of research by chemists of Foster D. Snell, Inc., of New York for the Navy Department's Bureau of Aeronautics.

Disappearing Threads

➤ THREADS that wash away will prove valuable in making skinless hot dogs, in detecting germs, and in producing a light-weight woolen, a Government scientist told the American Chemical Society meeting.

The disappearing thread is a chemically treated cotton yarn that dissolves in water, Dr. J. David Reid of the Department of Agriculture's Southern Utilization Research Bureau at New Orleans, La., explained to the Society.

Its uses are many, Dr. Reid said. One example would be to tie off the links of sausages after filling the casings. The thread would then disappear in cooking, thereby eliminating the need for removing the tie-links by hand as is now done.

Another use would be to make lace by "embroidering" it on soluble cloth and later dissolving away the backing material. Similarly, a light-weight woolen could be produced by blending wool with a soluble thread, then washing out the cotton and leaving a fabric with many tiny air spaces.

Dr. Reid also described a water-soluble filter for trapping airborne germs, where the filter is dissolved in sterile water and the germs left to grow on a culture.

The "disappearing" cotton can be made by treating it with ethyl-

ene oxide and dilute sodium hydroxide, or by subjecting it to the effects of nitrogen dioxide, Dr. Reid reported. These and other methods, he stated, do not seriously affect the breaking strengths of the threads.

Air-Refreshing Chemical

➤ THE CHEMICAL which fills the canisters that allow divers and fire fighters to breathe where there is no air is now made in quantity.

The fine grained yellow powder, a superoxide of the metal potassium, absorbs carbon dioxide and gives off the oxygen needed to sustain life. Moisture in the breath is sufficient to keep this chemical interchange going, so that a man can carry in his respiration canister a continually operating air re-conditioner.

Use of this device to keep the air supply breathable under "conditions of extreme exercise" was reported by Dr. C. B. Jackson of the Mine Safety Appliances Co., Callery, Pa., to the American Chemical Society's division of industrial and engineering chemistry. Dr. Jackson also described the process, developed by himself and Dr. R. C. Werner, for making the superoxide by automizing molten potassium with air.

A continuous process for making the pure potassium metal and alloys of potassium and sodium of any desired composition was described to the same meeting by Dr. Werner. Sodium vapor and molten potassium chloride are used in the process developed by these two chemists to produce these light metals, which are constantly finding new uses in chemical technology.

Handling Liquid Metals

➤ MELTED sodium and potassium and the alloy of the two which is liquid at ordinary temperatures pose new problems for chemical engineers, designing experimental atomic reactors using these previously unknown materials.

Pumps, flow meters for handling melted metals and indicators to show the level of the liquid metal in pipes were described by Dr. F. A. Smith of Argonne National Laboratories, Lemont, Ill., and Dr. H. W. Savage of Oak Ridge National Laboratory, Oak Ridge, Tenn. They explained these new techniques in chemical engineering to the division of industrial and engineering chemistry of the A.C.S.

Transfer of molten lithium, as well as methods of packaging this light, little known metal, and ways to fabricate it into rods, wires, shot and granules, were described to the chemists by Dr. H. C. Meyer Jr. of Foote Mineral Co., Philadelphia.

Safety in handling the novel metal was stressed by Dr. Meyer who described difficulties as due to lithium's relatively high melting point, hardness and ability to combine with nitrogen.

North Star Companion Found tho Invisible

Spectrograph Discovers Star

▸ THE EXISTENCE of an invisible companion of the North Star has been confirmed for the first time by a University of California astronomer, Dr. Elizabeth Roemer.

Dr. Roemer's findings come from a study of 1,200 spectrographic plates that have been taken at the university's Lick Observatory in the past 60 years.

Shifts in the light spectrum of Polaris indicate a motion that can be accounted for by assuming that the star circles in a small orbit around an invisible companion.

Actually, the North Star is a three star system. Only the white super giant, Polaris, the guide of navigators for centuries, is visible. The telescope shows up a second star, while the third, the invisible companion, is too faint and probably too close to the brilliant Polaris to be seen.

The invisible member of the system was first suggested in 1929 by Dr. J. H. Moore, former director of Lick Observatory. Dr. Moore found that Polaris, a "Cepheid variable" or pulsating star, has spectral irregularities suggesting orbital motion independent of the relationship to the visible companion. That indicated the existence of another stellar body, an invisible one, for Polaris to revolve around.

Dr. Moore found that the shifts in average velocity of each cycle apparently repeat themselves every 30 years. Dr. Roemer's work, close to the end of a cycle, permits the confirmation of the theory about one of the most familiar stars in the heavens.

Dr. Roemer's observations also permit classification of Polaris' visible partner — a dwarf star just a little hotter than our sun. She also found that the brightness of Polaris confirms recent findings that the universe is actually twice as large as astronomers had thought it to be.

Dr. Roemer's findings were made possible because she used the same instrument that had been employed in spectrographic measurements for the past 60 years. Lick Observatory is one of the few places where such measurements have been made.

Plenty of seed but too little lime and fertilizer is one cause of the "poor luck" many farmers have in establishing a good pasture.

Tests show that two new cortisone derivatives are three to four times more potent and at the same time less dangerous than older products.

Farm Has Cows, Sheep, Chickens Milk and Meat Are Not Produced.

Farming For Health

by DAVID M. CLEARY

➤ AT SWIFTWATER, PA., in the Pocono Mountains just above Stroudsburg, there is a farm which produces nothing you can buy in a grocery or supermarket. Rather, you are likely to obtain its products from your doctor or pharmacist, for its only "crops" are medicines.

The farm functions as the Biological Laboratories of Philadelphia's National Drug Company, and is typical of many such installations throughout the United States devoted to the growing of medicines with the aid of animals and plants.

Mostly, the products of biological laboratories are vaccines. Protection against a disease can be attained by triggering the production of antibodies. Sometimes this is done by setting off a mild attack of the disease itself, which subsides as soon as antibody production has been stimulated. In other cases, antibodies themselves are introduced into the body to provide immunity to the disease.

A vaccine to prevent smallpox, for example, is made of cowpox virus, which sets off the antibody response without the dangers inherent in an infection of smallpox itself. The cowpox virus, in turn, is grown on the skin of calves. From a small amount originally injected, the calf produces enough virus to provide a safe vaccination for hundreds of human beings.

In similar fashion, horses produce tetanus antitoxin and gangrene antitoxin. Compared to his cousins who pull wagons and plows, a horse at a biological laboratory has an easy life: that of a professional blood donor.

Given a small infection to set antibody production in motion, the horse develops stronger and stronger immunity to the disease. Once every six weeks, he painlessly donates two gallons of his blood to mankind, providing raw material for the serum your doctor administers when lockjaw threatens.

Sheep are raised at National Drug's medicine farm for neither their wool nor their meat, but in the same role as horses: blood donors. Sheep blood contains elements favorable to the growth of bacteria, and is contained in the food on which disease-fighting organisms are raised. The same blood is used for testing finished vaccines for safety.

Hens, too, are part of the farm population. Their eggs, fresh and

fertile, are inoculated with the viruses of influenza and yellow fever. Inside the living eggs, which are kept in incubators, the viruses increase and multiply until "harvest" time, when the virus is extracted for making vaccines.

The virus of yellow fever is a highly contagious one, so that vaccine is produced in a building separate from all others on the farm, with personnel taking special precautions to avoid contact with the germs. The National Drug Company is the only producer of yellow fever vaccine in the United States.

Plants are also grown on the medicine farm, but they are not such common ones as tomato vines or apple trees. Instead, they are tiny bacteria, as exemplified by the ones causing whooping cough. These germs, called pertussis, are grown in large flasks, then carefully measured for potency, screened for presence of unwanted foreign matter, and divided into dose units capable of preventing whooping cough.

Safety of the finished product is the constant watchword of biological manufacture. Before a vaccine can be released for human use, exhaustive tests are made, reports are filed with the Government, and each batch is held in quarantine until the Government's approval is received. In many of the safety tests, additional animals – rabbits, mice, guinea pigs and rats – play an important part.

Rabbits are more sensitive to fever than any other common animal. To test for the presence of fever-causing pyrogens in a vaccine, it is given to a rabbit. Usually the dose is far larger, in comparison to body weight, than will be used for mankind. The rabbit's temperature is then taken every hour, and if any fever shows up, the batch is discarded, even though a child would have little or no chance of becoming feverish after a normal dose.

Guinea pigs, rats, and mice similarly serve to check the purity, potency, and safety of each batch of vaccine. Each animal has certain physiological characteristics which provide a sensitive measurement of the effect a medicine will have on humans.

As a result of these procedures, in which animals act as both manufacturing plants and testing stations, several once-dreaded diseases are now rare. Protective vaccinations provide immunity against diphtheria and smallpox among school children. When other afflictions break out, they can be prevented from spreading by vaccinating others nearby.

Those who recall the epidemics of influenza during the first World War, and mothers who remember the prevalence of whooping cough just a few years ago can thank the animals of biological laboratories and the trained people who work

with those animals for the fact that we no longer consider those illnesses serious.

Despite the improved state of our national health now that vaccines are in general use, there are some people who oppose the use of animals in vaccine production. They feel that the animals are undergoing terrible suffering for the benefit of humans, and that we are not justified in torturing animals that way.

Actually, an animal producing viruses or antibodies for vaccines is not in pain, no more than the child who goes through the same process to attain immunity. As in humans, there is a slight twinge when the vaccination is first done, and the prick of the needle as blood is withdrawn, as when humans donate blood to the local blood bank.

If a poll could be taken among horses producing tetanus antitoxin, it is a pretty good bet that they would rather donate blood every few weeks than work on an ordinary farm.

Would Get Rid of Cotton Poison

➤ THE U.S. Department of Agriculture is experimenting to develop new cotton varieties that have the poison glands bred out of cotton. Common cotton plants contain poison glands that make cottonseed meal dangerous as a livestock feed to many animals unless it is given a "de-poisoning" treatment.

The poison glands, scattered throughout the cotton plant and especially in the seeds, produce a toxic pigment called gossypol. Because of the presence of gossypol, feeding of cottonseed meal was long restricted to cattle and sheep which are unaffected by the poison.

Later, methods of obtaining cottonseed oil and meal by pressing and cooking caused inactivation of gossypol, and today's commercial meal can be fed safely to chicks and broilers (but not laying hens) and to swine.

The USDA, however, wants to breed the poison glands out of cotton, and already has encouraging results in early tests. Cotton geneticists with the USDA have observed certain plants of both commercial upland cotton and primitive Hopi varieties with unusually small numbers of the glands. Some parts of these plants are completely gland-free.

The scientists are now trying to breed the glandless character existing in parts of these plants into a single variety of cotton which would be completely free of the gossypol glands.

New Textile Machinery Can Handle Synthetic Fibers Too

Spinning a Yarn

Reprinted from the **Industrial Bulletin** of Arthur D. Little, Inc.

➤ MODERN spinning mills employ the same basic series of operations used when yarnmaking was a household art. There has been continued improvement, however, in preparatory textile machinery—the mill equipment used to convert raw fibers into yarn. Today's machines operate at higher speeds, require fewer operations and less direct labor, and are far more productive than the models of even a few years ago.

The first hand operation preparatory to cloth making was "carding" or brushing the raw fibers until they were straight and somewhat parallel, and some impurities and imperfections were removed. This used to be done by drawing the fibers through two "stock cards," or wire brushes—one stationary, the other manipulated by hand. Machine techniques are far more complicated, comprising four individual operations that may each require several steps. Carding, as the initial operation is still called, separates individual fibers, draws them out parallel, eliminates lumps and impurities and produces a uniform round rope or sliver (frequently pronounced sly'ver). In the carding machine, the fibers pass between rotating cylinders covered with "card clothing" — a thick material containing many wires. The carded stock is stripped from the cylinders in a thin film of fibers known as a web, which is in turn drawn through a tapered tube to form the sliver.

Combing, the second preparatory process, eliminates short fibers in the sliver and increases parallelization, in order to permit the spinning frames to produce finer yarns. The sliver must next be converted into roving small enough to be spun easily; this is done by two closely allied processes, drawing (or drafting) and roving, on machines equipped with several pairs of rollers—running at different speeds—through which the sliver is passed. Sometimes as many as five separate operations are needed to reduce the sliver sufficiently.

The basic principle of spinning —arranging parallel fibers into a yarn of continuous length — remains the same, although modern machines are a far cry from hand-operated equipment. In ancient Egypt, yarn was spun by using two crude implements: a distaff

or stick, bearing a loosely wound mass of carded fibers, and a smaller, weighted stick called a spindle, to which a strand of fiber from the distaff was attached. The spinner held the distaff under his left arm, and with his left hand guided fiber from the distaff to the spindle, which he rotated with his right hand. The Saxony wheel, introduced in the sixteenth century and the model for the familiar spinning wheel, initiated the method of revolving the spindle by attaching it to a flywheel operated by a foot treadle. A bobbin, also rotated by the flywheel, but at a different speed, collected the spun yarn; the revolution of the spindle caused the yarn to twist and the difference in speed of the two wheels accomplished the winding-on process.

Spinning now consists of three basic steps — drafting, twisting, and winding. Drafting, which is usually done by either rollers or pins, is a final drawing-out of the sliver to make a longer, slimmer yarn. The strength of yarn is determined by the amount it is twisted; the greater the twist, the harder the yarn. The finished yarn is wound into packages suitable for further use.

New developments in textile processing machinery are constantly simplifying and improving the many operations of yarn-making. A new device called the Autocount, for example, controls the density of the web formed during the carding process; until recently, there was no means of doing this automatically. By using a photoelectric cell to monitor the relative speed of the rotating members in the card the Autocount reduces the processing needed to prepare the sliver for spinning.

A new cotton comber has partially eliminated the shock and inertia problems met in earlier machines, and has increased speed of operation by an estimated 18 per cent; another new machine has combined operations of fiber combing and straightening. A further development, still in the experimental stage, is a precision, gear-driven spindle for spinning and twisting machines, said to compare favorably with a belt-driven spindle, and to operate as fast as 15,000 rpm.

The design of a frame on which yarn can be spun directly from silver has eliminated the roving operations needed — at least for coarse cotton yarns. Worsted yarn production, which is inherently more complicated, has been simplified by adoption of the American System, a method that comprises three drawing operations to blend and parallelize fiber, one roving operation to reduce the size of the sliver, and one spinning operation. The American System was evolved during the 1930's when mills wanted to pro-

duce synthetic yarns on their cotton-processing machinery. It was not until a few years ago, however, that the system was adapted to worsted yarn production; today it is the accepted method for handling any fibers up to four inches long – wool, viscose, acetate, nylon, and various other synthetics. It contrasts with the thirteen-operation French System for spinning short fibers, and the Bradford System, which produces yarn from longer fibers in nine separate processes.

Many other improvements have been made on textile machinery used in all phases of the industry from yarn-making to cloth treating. The emphasis is on speeding up production; already the $350 million worth of new equipment bought during 1955 has helped bring about the biggest gross sales volume in the textile industry since 1950.

"Green Claw" Chemicals Aid Plants

➤ PLANTS and trees, whose pallor and lack of productivity are caused by an iron deficiency, may be helped by a "green claw" instead of the traditional "green thumb."

Dr. Arthur Wallace, agriculturist at the University of California at Los Angeles, who has pioneered western research on problems of plant anemia (or chlorosis as it is more properly called), says the new compounds of claw-like chemicals may be the answer to chlorosis.

These compounds, known as chelates, are named after the Greek word for claw because of a claw-like chemical structure which literally holds iron atoms tightly in its grasp.

Several years ago in Florida, Dr. Wallace points out, it was found that chelates administered to soil around trees caused pallid fruit trees to become a rich green and increased productivity in several cases.

But the iron in these chelates, which had worked so well in Florida's sandy soil, was not readily absorbed by plants from the alkaline, clay soil of the West. One reason was that the alkalinity of western soil tended to precipitate the iron from the compounds. But there were other complicating factors.

Dr. Wallace and his colleagues recently found that the iron atoms fix to the clay in the soil. Thus plants could not absorb them.

With these clues the chemical industry went to work. Evaluation by the group of compounds recently developed by the industry indicate that the new compounds can overcome alkalinity and clay problems.

New Patents Point the Way Toward Industrial Development

New Trends in Chemical Processes

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Organosols

➤ A NEW GROUP of chemically-resistant and corrosion-resistant organosols based on polytetrafluoroethylene have been invented and the patent rights to patent No. 2,718,452 assigned to E. I. du Pont de Nemours and Company of Wilmington, Del.

Invented by Dr. John Frank Lontz of Wilmington, the new composition permits the application of this polymer in spinning into filaments, for coating various surfaces, as well as in casting unsupported films. Heretofore, Dr. Lontz claims, no entirely satisfactory means have been available for applying thin, continuous coatings of this polymer to various surfaces.

Being highly resistant to practically all solvents, the organosols will prove useful as coatings and linings, such as in impregnating asbestos, a water-sensitive material.

Radio Pulse

➤ ANOTHER use for radioactivity has been found, this time for radio activity. Ernest G. Linder and M. Christian of Princeton, N. J. have invented a radio pulse system that utilizes radioactive materials for its primary power source.

With the use of radioactive cobalt 60 or strontium 90, by-products of the manufacture of fissionable substances, radio pulse generators and transmitters can be made for unattended operation over a long period of time.

As outlined in their patent, the inventors state that charges continuously emitted by the radioactive material are stored until there is accumulated a substantial electrical charge. This is then converted to a short burst of oscillatory energy.

The radioactive unit, hermetically sealed, is seen by the inventors as uniquely suited for use as radio beacons in frigid, arid or mountainous regions where it is difficult to install and service a conventional radio beacon.

The invention received patent No. 2,720,582 and its rights were asigned to the Radio Corporation of America.

Fluid-Tight Concrete

➤ AN AUSTRALIAN inventor has devised a way to make concrete fluid-proof and gasproof.

The process involves spraying or painting freshly poured concrete, after the mold is removed, with a mixture comprising 50 parts of a five precent solution of sodium alginate, and 50 parts of rubber latex. This produces a thin protective film. After the film is formed a protective layer of one-half inch or more of cement mortar is placed over it.

The proofing process is the invention of Wilhelm Serkin of Melbourne, Australia, and was granted patent No. 2,720,469. Mr. Serkin assigned the patent rights to Rocla Pipes Limited of Victoria.

Makes Snow and Hail

➤ DR. VINCENT J. SCHAEFER, the General Electric scientist credited with the discovery of artificial rain making by seeding clouds with dry ice, received a patent for a device to study the formation of snowstorms and hailstorms.

The rain maker's invention is a new method and apparatus for studying the formation of ice crystals. With the chamberlike monitor, Dr. Schaefer hopes to learn more about ice nuclei, the minute particles suspended in the atmosphere that serve as the centers of formation on which ice crystals grow.

Dr. Schaefer states in his patent that this information is extremely important in meteorological work, "since the presence or absence of such ice nuclei is a controlling factor in the formation of ice crystals, which in turn constitute the elemental particles out of which snowstorms and hailstones are formed."

The detector for trapping and monitoring the minute crystal-forming particles was assigned patent No. 2,721,495 and Dr. Schaefer assigned his patent rights to the General Electric Company.

Ice-Free Jet Fuel

➤ AN IMPROVED aviation fuel that will not plug the filters in aircraft fuel systems and that prevents ice formation received patent No. 2,722,099.

Designed for use with turbojets, turboprops and ramjets, the fuel insures that small ice particles frozen in the fuel will not plug fuel filters. To do this, Theodore B. Wasserbach of Cranford, N. J. has added particular polyethelene glycols to the aircraft fuels.

Tests show that this addition will deter plugging even if the fuel is subjected to temperatures as low as 58 degrees Fahrenheit below zero. Mr. Wasserbach assigned the patent rights to the Esso Research and Engineering Company of Delaware.

To Harness Nuclear Energy

➤ AN INVENTION that permits man to harness part of the energy released in a nuclear reactor and use it for electrical energy has received a government patent.

The device, invented by Dr.

Volney C. Wilson of Santa Fe, N. Mex., collects beta rays and extracts them directly from the reactor through terminals as electrical energy.

In operation, the uranium or other fissionable rods of a reactor are surrounded by cylindrical beta collectors of copper or any other suitable electrical conductor. A space is left between the uranium and the conductor as insulation.

Awarded patent No. 2,728,867, Dr. Wilson assigned the patent rights to the United States of America as represented by the Atomic Energy Commission.

Synthetic Mica

➤ SYNTHETIC mica can now be made into sheets with surface area at least 20 square inches and up to 10 square feet or larger.

Continuously formed sheets or ribbons of the man-made mineral are attained by flowing a thin layer of synthetic mica melt into a cooling or crystallizing zone, where it is crystallized. At this stage, states the inventor, Frank J. Dobrovolny of Lewiston, N.Y., a temperature difference of 20 degrees Centigrade must be maintained between the solid crystal formed and the thin stream liquid-crystal interface, The resulting mica sheet is then rapidly withdrawn.

The synthetic mica is made from commercially available raw materials. A furnace for melting and fining the mica melt may be the same as that used to make sheet glass. Mr. Dobrovolny has in this way produced mica sheets which he claims are larger in area surface than have been produced ever before.

He was awarded patent No. 2,741,877 and assigned the patent rights to E .I. du Pont de Nemours and Company of Wilmington, Del.

Curium 243

➤ THREE ATOMIC scientists received a patent for the production of the isotope of curium having a mass number of 243.

The production of this isotope from element 96 was made during the search in the field of transuranium elements to find the heavy isotopes of the newly discovered and created elements brought about by the release of atomic energy.

Curium 243 was produced by the bombardment technique, wherein americium 241 was a target bombarded with a beam of 40,000,000 electron volt helium ions from a cyclotron. What resulted was a nuclear transformation of the americium 241 yielding curium 243. The new isotope was discovered by Drs. Stanley G. Thompson, Burris B. Cunningham and Albert Ghiorso of the University of California at Berkeley.

They were awarded patent No. 2,741,627 and assigned the patent rights to the United States of America as represented by the Atomic Energy Commission.

Book Condensations

A Manual of Paper Chromatography Electrophoresis – Richard J. Block, Emmitt L. Durham, Gunter Zweig and others– *Academic,* 484 p., illus., $8.00 A practical manual summarizing proved procedures employing simple equipment and available reagents.

A Laboratory Manual of General Chemistry – Saverio Zuffanti, Arthur A. Vernon and W. F. Luder – *Saunders,* 310 p., illus., paper $3.75. Although written with one textbook in mind, the "General Chemistry" of the same authors, it is possible to use it with any first-year textbook and various kinds of laboratory courses.

Laboratory Manual of Biochemistry – Benjamin Harrow, Ernest Borek, Abraham Mazur, Gilbert C. H. Stone, and Harry Wagreich – *Saunders,* 4th ed., 164 p., illus., paper, $3.00. New experiments added include one on filter paper chromatography.

General Chemistry – L. E. Steiner and J. A. Campbell – *Macmillan,* 673 p., illus., $6.50. A beginning college text.

Laboratory Experiments in General Chemistry – J. A. Campbell and L. E. Steiner–*Macmillan,* 216 p., illus., paper, $3.40. Describing experiments that will enable the student to discover new facts for himself rather than merely confirming what he already knows.

Physical Chemistry – Farrington Daniels and Robert A. Alberty – *Wiley,* 671 p., illus., $6.50. A textbook for a first course in physical chemistry with emphasis on practical examples.

Techniques in Clinical Chemistry: A Handbook for Medical Laboratory Technicians –Frederick N. Bullock – *John Wright and Sons,* (*Williams & Wilkins*) 171 p., illus., $4.00. Intended to supplement rather than replace more exhaustive manuals, and answering the question "why" more often than "how."

New Methods in Analytical Chemistry – Ronald Belcher and Cecil L. Wilson – *Reinhold,* 287 p., illus., $5.50. A compilation of newer methods based on classical techniques.

Manual of Elementary Practical Chemistry –R. D. Brown and T. A. O'Donnell – *Melbourne University Press* (*Cambrige University Press*) 185 p., illus., $4.75. Intended for students taking first-year chemistry at the university level.

An Introductory Laboratory Course in Chemistry – Howard L. Ritter – *Wiley,* 119 p., plus data sheets, illus., paper, ring binder, $2.50. Following closely the author's textbook.

Proudly Presented

➤ HYDROGEN PEROXIDE of concentrations ranging between 90% and 100% H_2O_2 is described in Bulletin 70 of the Becco Co. Stability, solubility, energy content, hazards, containers, engineering materials for handling, and analysis procedures are given, together with a simplified description of the continuous fractional crystallization process which makes this remarkable product possible. A free copy of the bulletin may be obtained from Becco Chemical Division, Food, Machinery and Chemical Corporation, Station B, Buffalo 7, N. Y.

➤ CHROMATOGRAPHY has been made easy by a new line of self-contained instruments for gas and vapor phase chromatography. The Kromo-Tog Model K-2, which accommodates two columns for duplicate or for different samples, is offered in Booklet 83 by the Burrell Corporation, 2223 Fifth Avenue, Pittsburgh 19, Pa.

➤ A NEW BOOKLET, which discusses the uses, advantages, and suggested proportions of chemicals for latex resin emulsion, has just been released by Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation.

Among the products discussed are an extensive group of monomers valuable in "tailor-making" resins, either as homopolymers or as copolymers. Emulsifiers and protective colloids are reviewed in relationship to emulsion polymerization. Physical modifiders discussed include plasticizers, solvents, thickeners, dispersants, and stabilizers.

Copies of this booklet are available from Carbide and Carbon Chemicals Company, 30 East 42nd Street, New York 17, New York. Ask for F-8869A.

➤ A TIME-SAVING chart designed to be used in costing and other operations connected with precious metal electroplating is being distributed by Technic, Inc. Purpose is to save the electroplater most of the time usually consumed in consulting various tables, and above all to insure him against errors.

The new Technic chart provides at a glance all related and comparative data on gold, rhodium, palladium, platinum, silver and nickel. Much of the information has never before been compiled in a single convenient reference unit. Copies are available on request from Technic Inc., 39 Snow Street, Providence 1, Rhode Island.